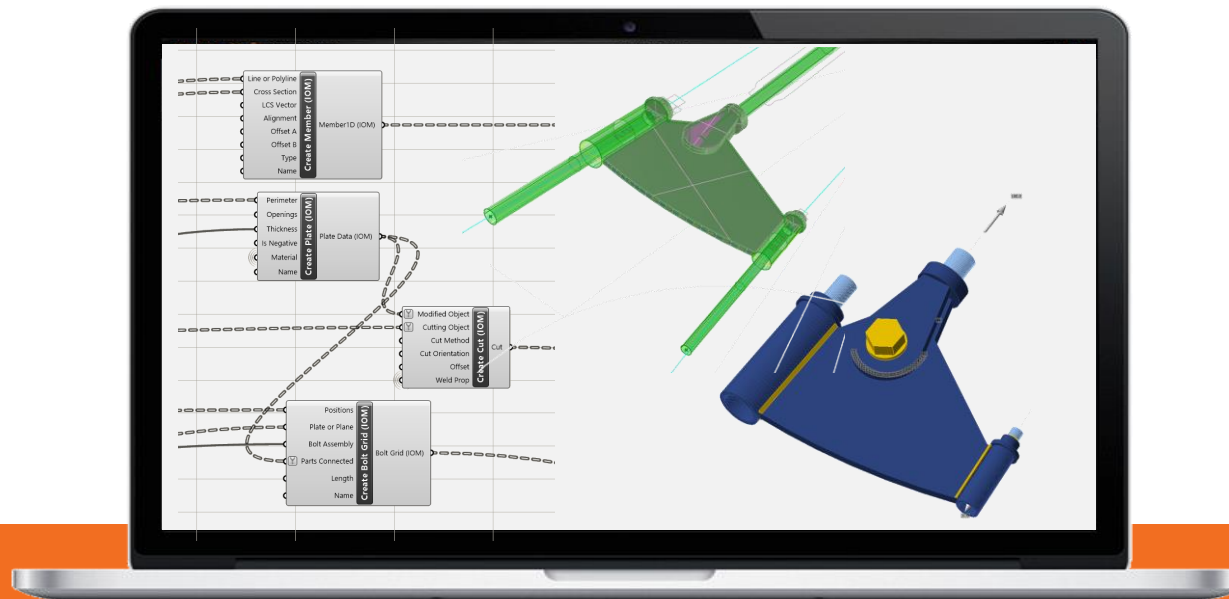


# IDEA StatiCa Grasshopper

## Learn Grasshopper



January 31, 2023

# Presenting Today



**Nathan Luke**

BIM & API Specialist

IDEA StatiCa HQ

[linkedin.com/in/nathan-luke](https://www.linkedin.com/in/nathan-luke)

**Buildings Structures Engineer**

Aurecon + Buro Happold

**BIM Consultant**

Geometry Gym

**BIM and API Specialist**

IDEA StatiCa



*Calculate yesterday's estimates*

IDEA StatiCa is the solution for the structural design of steel connections, concrete D-regions, and general members.

[www.ideastatica.com](http://www.ideastatica.com)

10,000+  
desktop  
licenses

Software  
results  
validated by  
universities

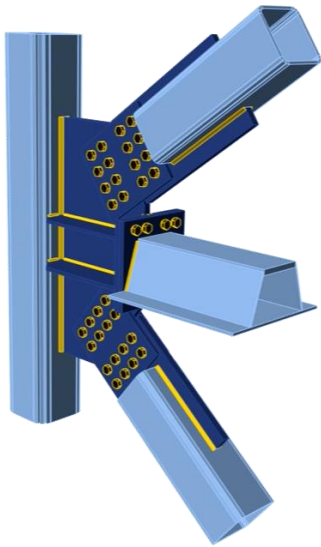
Linked to  
20+ FEA/CAD  
programs

80+ employees  
40+ resellers

# IDEA StatiCa Connection

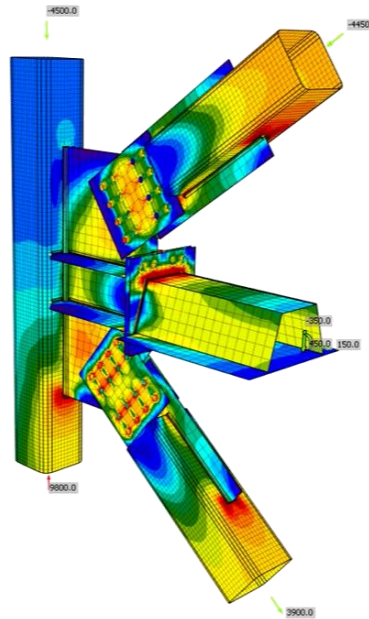
Component based finite element modelling (CBFEM)

Connection Model



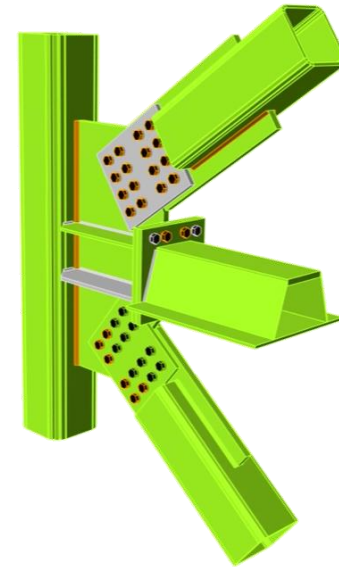
Any geometry, Any loading

FEA Analysis



Automated FEA model

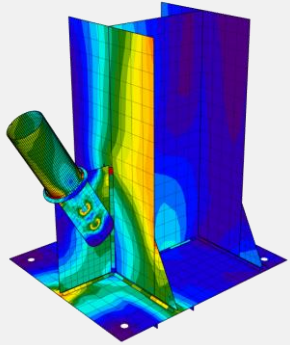
Design



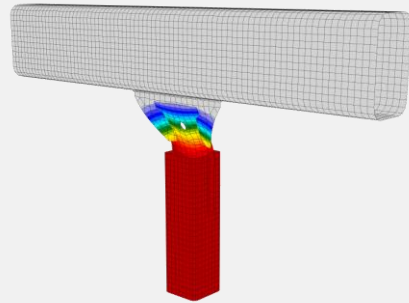
Component based design

# All code-checks for your project

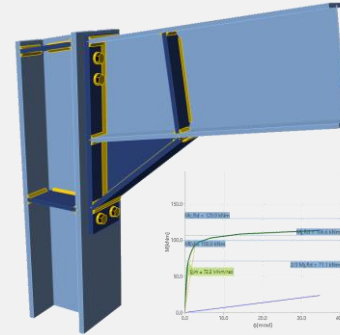
Stress/strain analysis



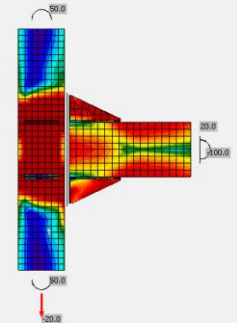
Buckling analysis



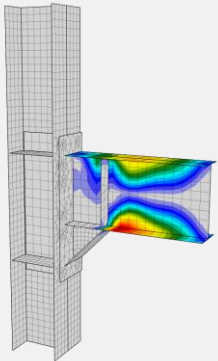
Stiffness analysis



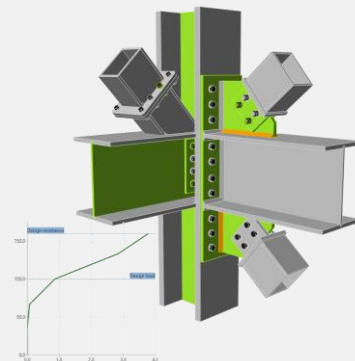
Fire analysis



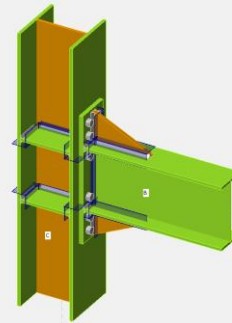
Seismic capacity design



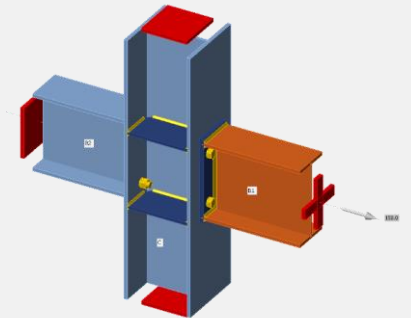
Design joint resistance



Fatigue



Horizontal tying



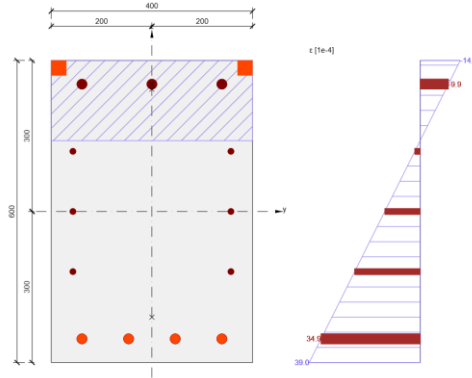
## Member

-

# Concrete Design

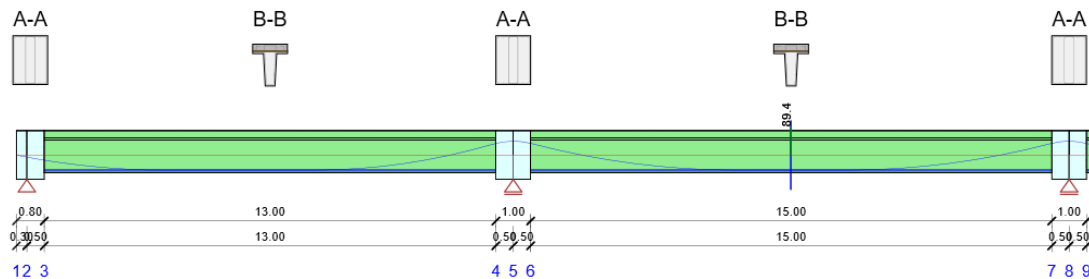
## RCS

- 1D section checks
- Code-based calculation
- All checks for ULS and SLS
- NEW RCS API



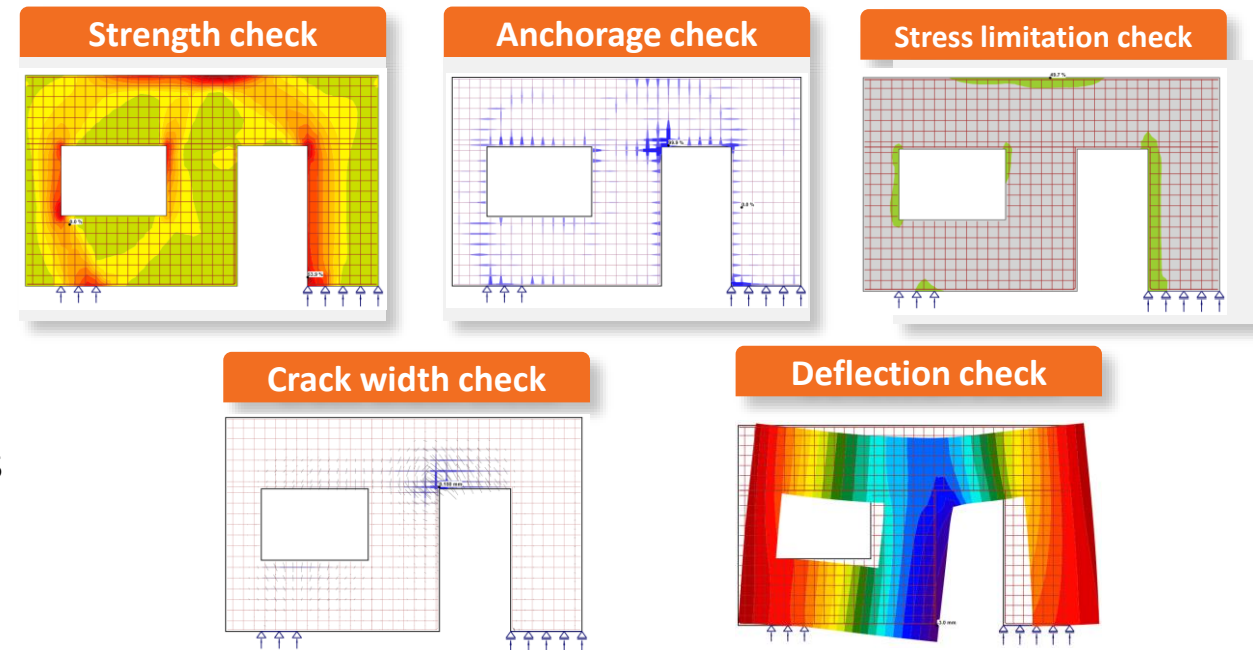
## Beam

- For **straight (2D)** or **polygonal (3D)** beams
- Developed especially for 2D FEA structural analysis
- Single-span or multi-span beams including TDA analysis



## Detail

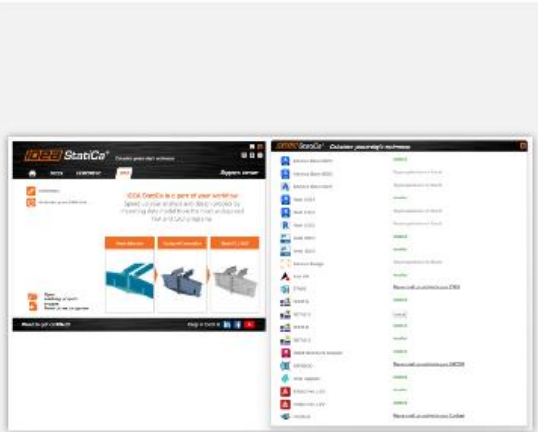
Any geometry and loading for any wall, member, and D-region



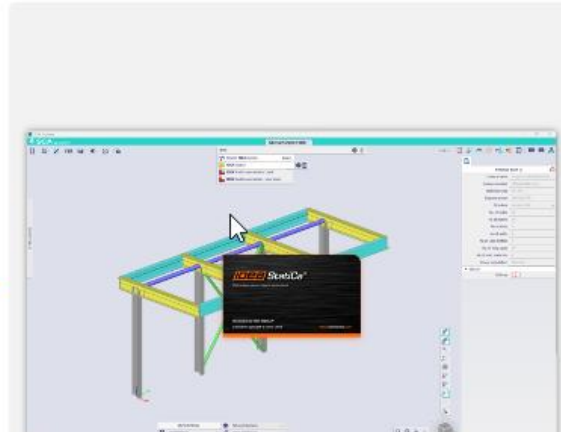
# BIM Links

## Checkbot

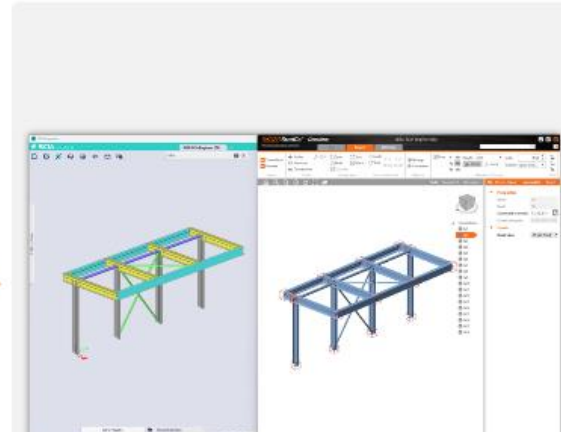
- The hub for structural design.
- Direct import, sync and management of connections and members
- 20+ links



Install plugin



Run checkbot



Import structure

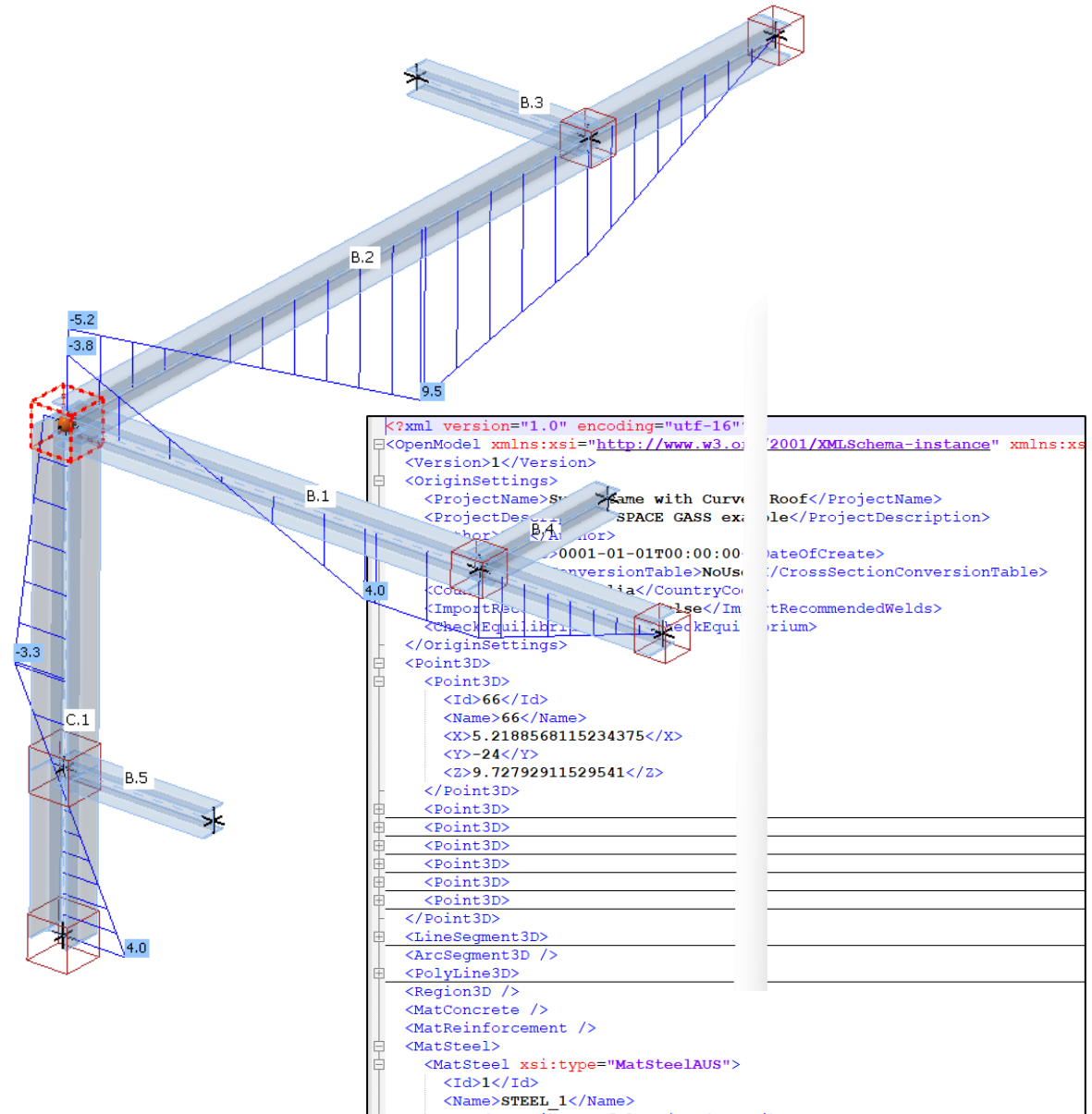


Design and check

<https://www.ideastatica.com/bim-integrations>

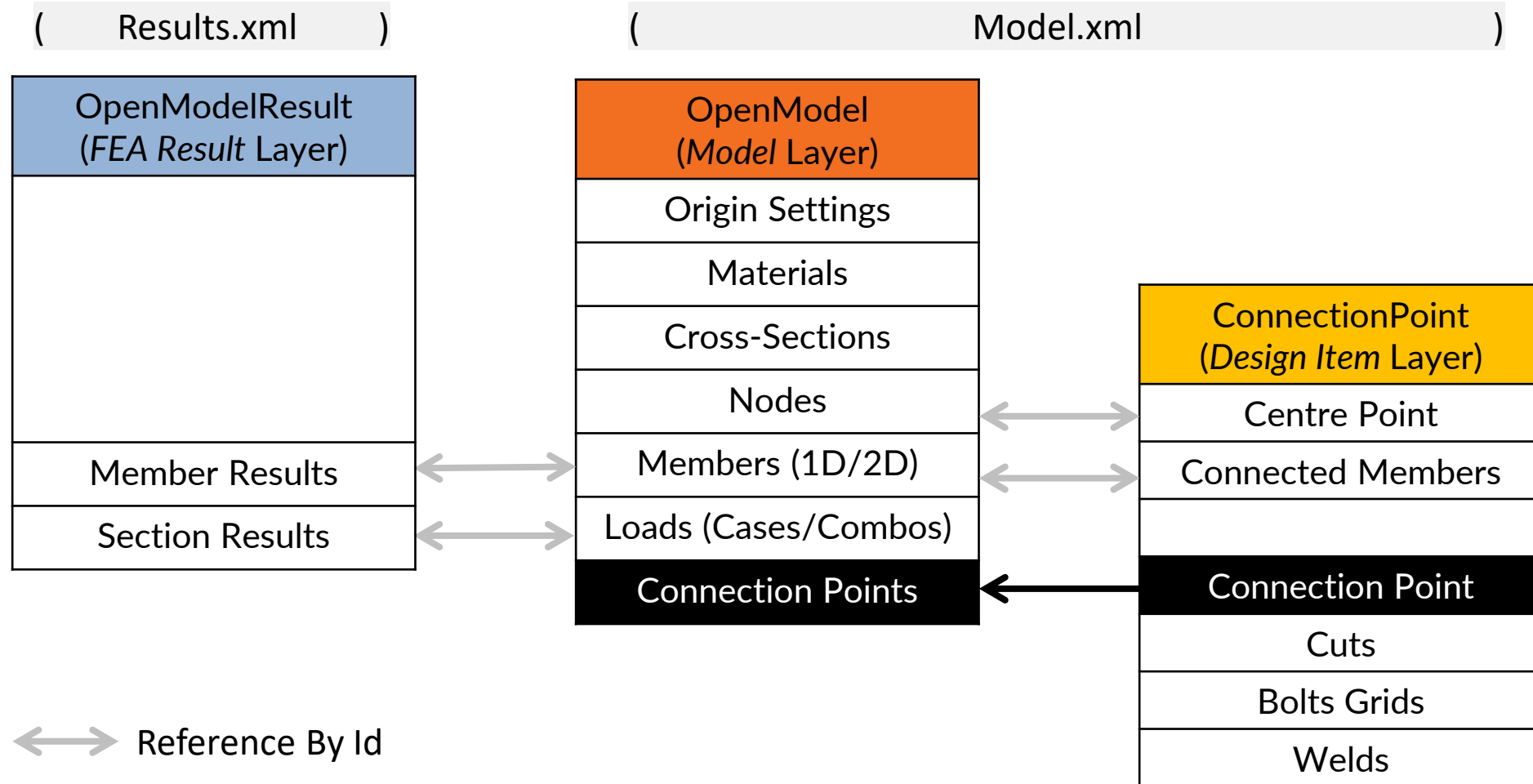
# IDEA Open Model (IOM)

- Open-source object model to describe FEA or BIM models.
- Developed by IDEA StatiCa to interact natively with IDEA StatiCa Apps: [Checkbot](#), [Connection](#), [RCS](#), [Beam](#), [Detail](#).
- Anyone can create an importer or exporter for IOM or use it to transfer BIM or Analysis Data. It's **FREE**.
- Source code in on our GitHub
- Transferred as XML file.



# IDEA Open Model (IOM)

## IOM Model Definition



# IOM Import

Checkbot allows us to import, and view created Open Model.














The screenshot displays the IDEA StatiCa Checkbot software interface. The top menu bar includes 'Project', 'Materials', and 'Plugins'. The main toolbar contains various icons for file operations, model manipulation, and analysis. A red box highlights the 'IOM' icon in the 'Connections Open in Viewer' section. An orange arrow points from the text 'Import IOM (.xml)' to this icon. Another orange arrow points from the text 'Model Layer' to a 3D model of a steel structure. The 3D model shows a complex steel frame with members labeled B.1, B.2, B.3, B.4, B.5, C.1, and C.2. A blue box highlights the 'Member ID Forces' section in the top right, showing a table of forces (N, Mx, My, Vz, Mz) and a 'Scale' dropdown set to '1.00'. A red box highlights the 'Connections' list in the 'Properties' panel, showing connections SJ.1, SJ.2, SJ.3, SJ.6, and SJ.7. A blue arrow points from the text 'FEA Result Layer' to this list. The bottom right shows a detailed view of a connection (SJ.3) with a 3D model and a list of members and load effects. A yellow box highlights this list, with a red arrow pointing from the text 'Design Item Layer' to it. The list includes members C.1, B.1, B.2, load effects LOAD(1), operations CUT1, EP1, STIFF1, and CLEAT1. A red note below the list states: '\*Load effects 'generated' from result layer'. The bottom status bar shows 'Design code: EN' and 'Analysis: Stress, strain'.






FEA Result Layer

Design Item Layer

\*Load effects 'generated' from result layer

# Structural Analysis Format (SAF) Support

SAF implementation	 SCIA	 FRILO	 Risa	 Graphisoft	 Allplan	 Radimpex	 LIRA SAPHIR	 AxisVM	 FEM-Design	 Sofistik	 Dlubal	 ConSteel	 mbAEC StrukturEditor	 die. D.I.E	 InfoGraph
Supported version	1.0.5 - 2.1.0	1.0.5	2.0.0	1.0.5 - 2.0.0	1.0.5 - 2.1.0	1.0.5 - 2.0.0	2.0.0	1.0.5 - 2.0.0	1.0.5 - 2.0.0	1.0.5 - 2.1.0	1.0.5	1.0.5 - 2.0.0	1.0.5 - 2.0.0	1.0.5 - 2.0.0	1.0.5 - 2.0.0
Import	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Export	Yes	No	Yes	Yes	Yes	Yes	No	Yes	No	Yes	Yes	No	Yes	Yes	Yes

 IDEA	 MINEA	 NextFEM	 MasterSap	 Prota Structure
1.0.5 - 2.1.0	1.0.5 - 2.1.0	2.1.0 - 2.2.0	1.0.5 - 2.1.0	1.0.5 - 2.1.0
Yes	Yes	Yes	Yes	Yes
No	No	Yes	Yes	Yes

KARAMBA3D

Coming soon!

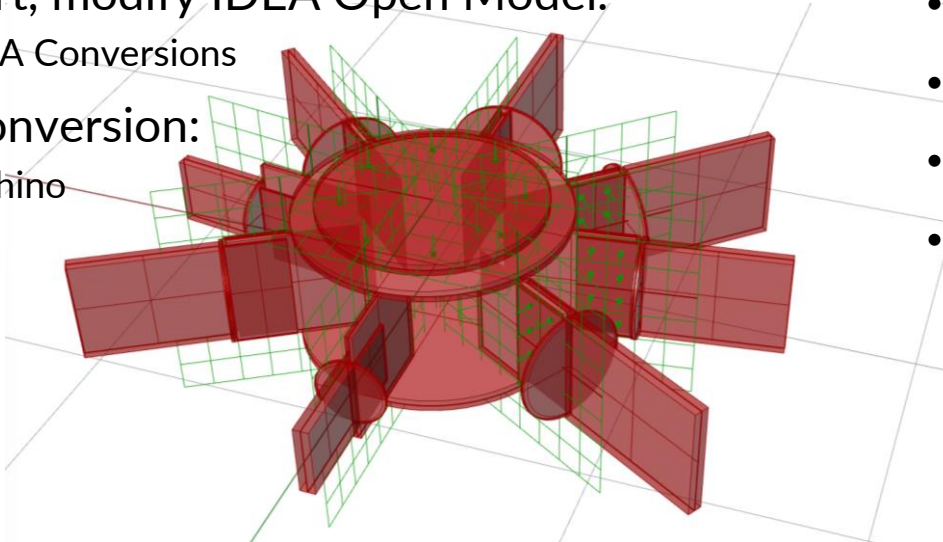
<https://www.saf.guide/en/stable/getting-started/who-supports-saf.html>

# IDEA StatiCa Grasshopper Plugin

## IDEA Open Model Components



- Import of IOM and SAF
- Explicit modelling of members, plates, bolts, cuts and welds.
- Create, import, modify IDEA Open Model.
  - Custom FEA Conversions
- Geometric conversion:
  - IOM <-> Rhino



## IDEA Connection API Components



- Create, import, modify connection files
- Get and update geometry
- Apply templates
- Get and update connection parameters.
- Get production cost of connections.
- Calculate connections and get results.
- Generate connection reports

# IDEA StatiCa Grasshopper Installation

## Installation

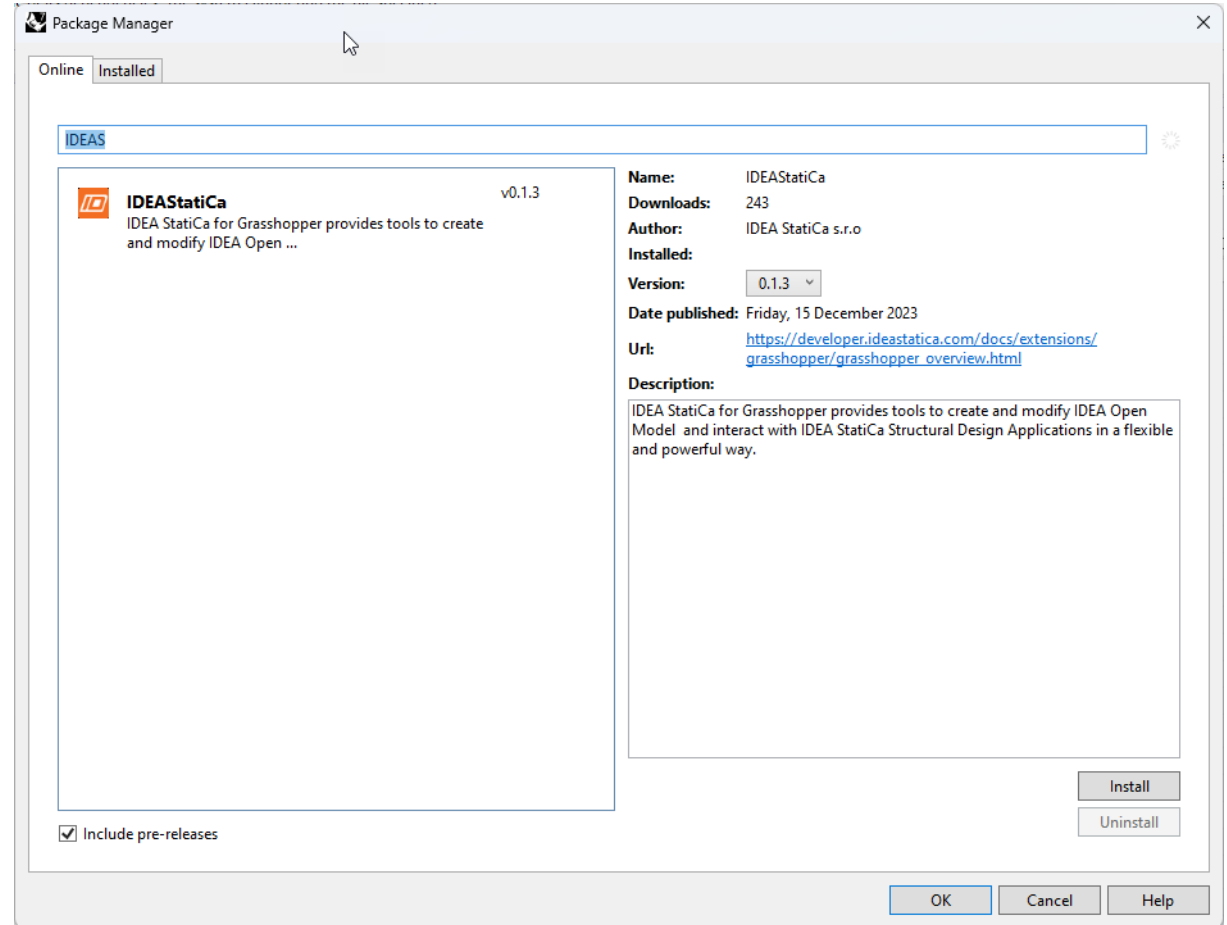
- Install via the Rhino Package Manager
- Built for Rhino7
- Can be used with Rhino8
  - (SetDotNetRuntime = NetFramework)

## Examples

- Every example is available when installing the plugin.
- %AppData%\McNeel\Rhinoceros\packages\7.0\IDEAStatiCa\Examples.zip

## Documentation

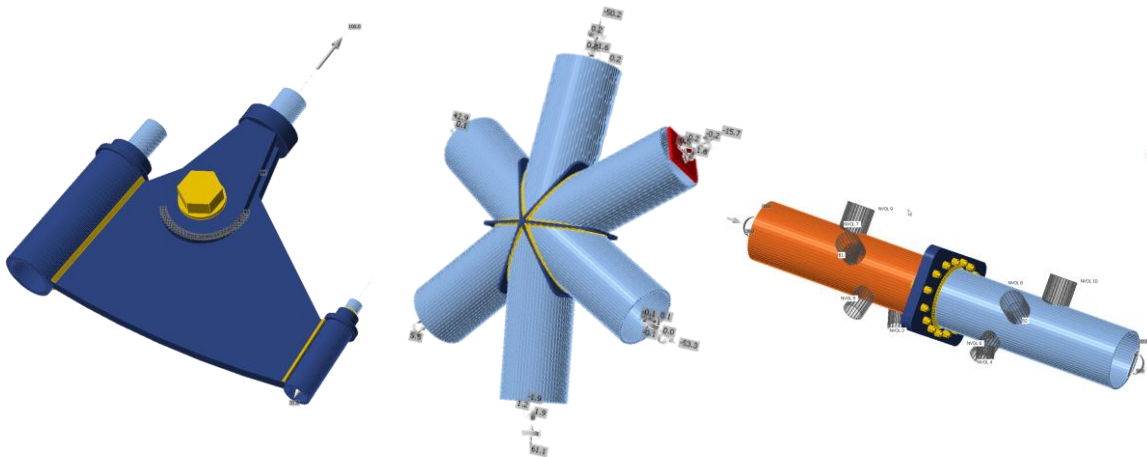
- [developer.ideastatica.com/docs/extensions/grasshopper/](https://developer.ideastatica.com/docs/extensions/grasshopper/)



# Explicit vs template

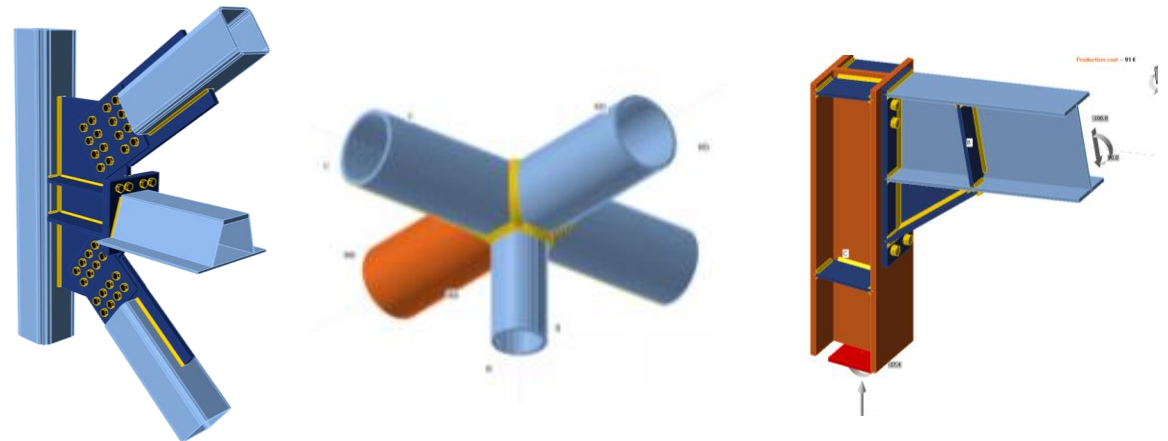
## Explicit Component Geometry (IOM)

- A **powerful geometry engine** is required to model effectively
- **Component** positioning or geometry is not relative to a single member.
- **Differing number** of connected elements with similar topology
- **No primary** member



## Template application

- Geometry differences can be **handled by UI** input properties or parameters.
- **Component** positioning relative to member co-ordinate systems.
- **Same number** of members in connection

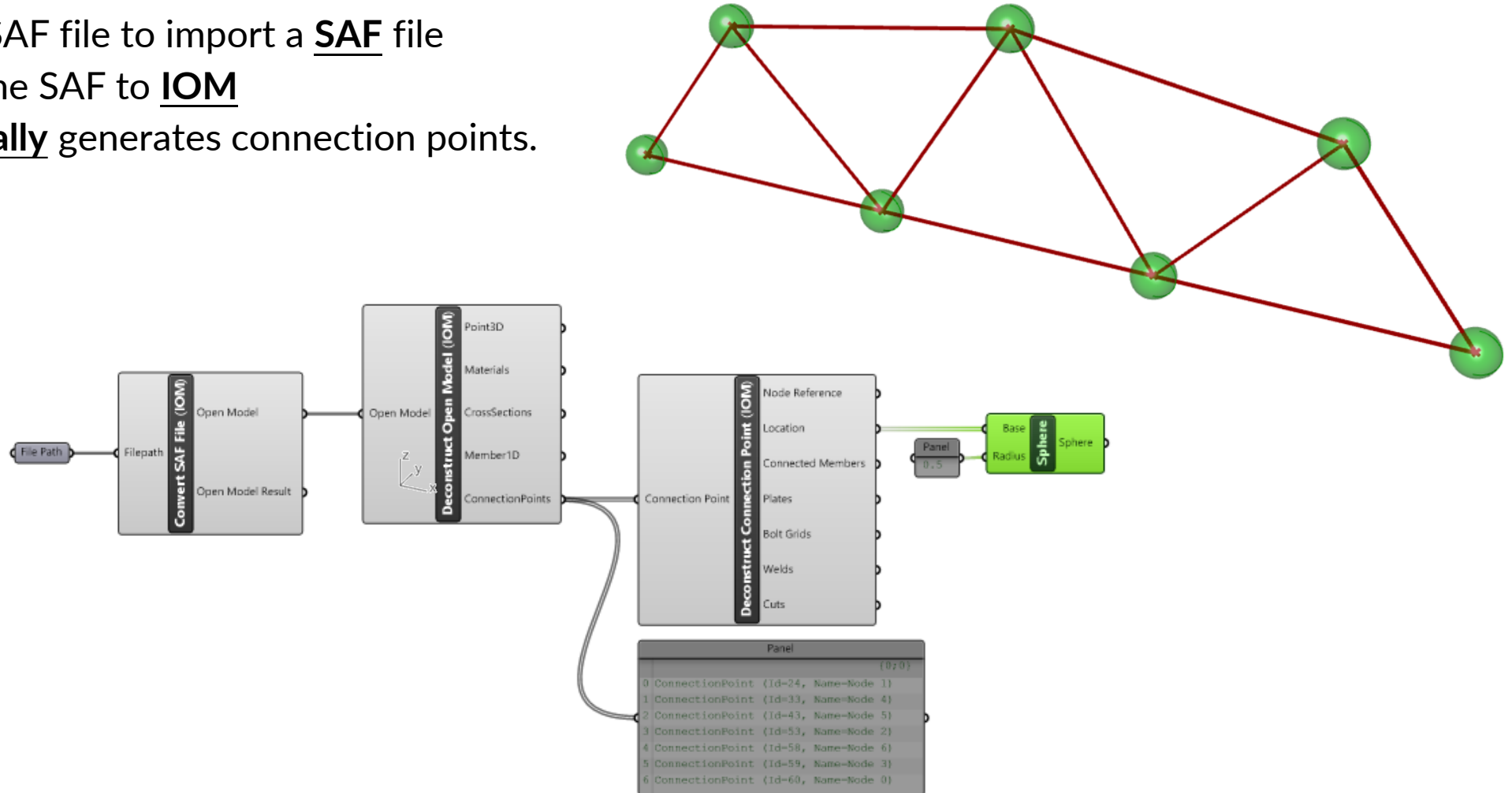
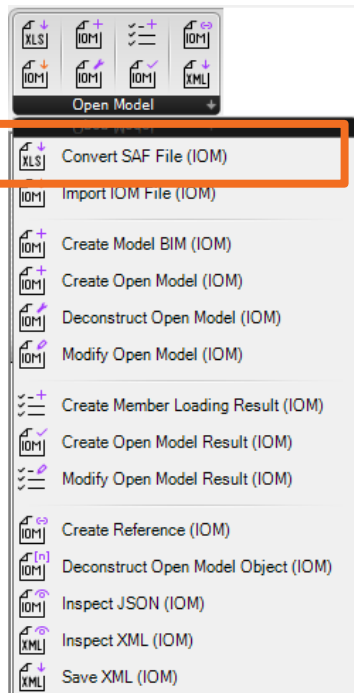


# Explicit Component Geometry

## SAF > IOM

Use the Convert SAF file to import a SAF file

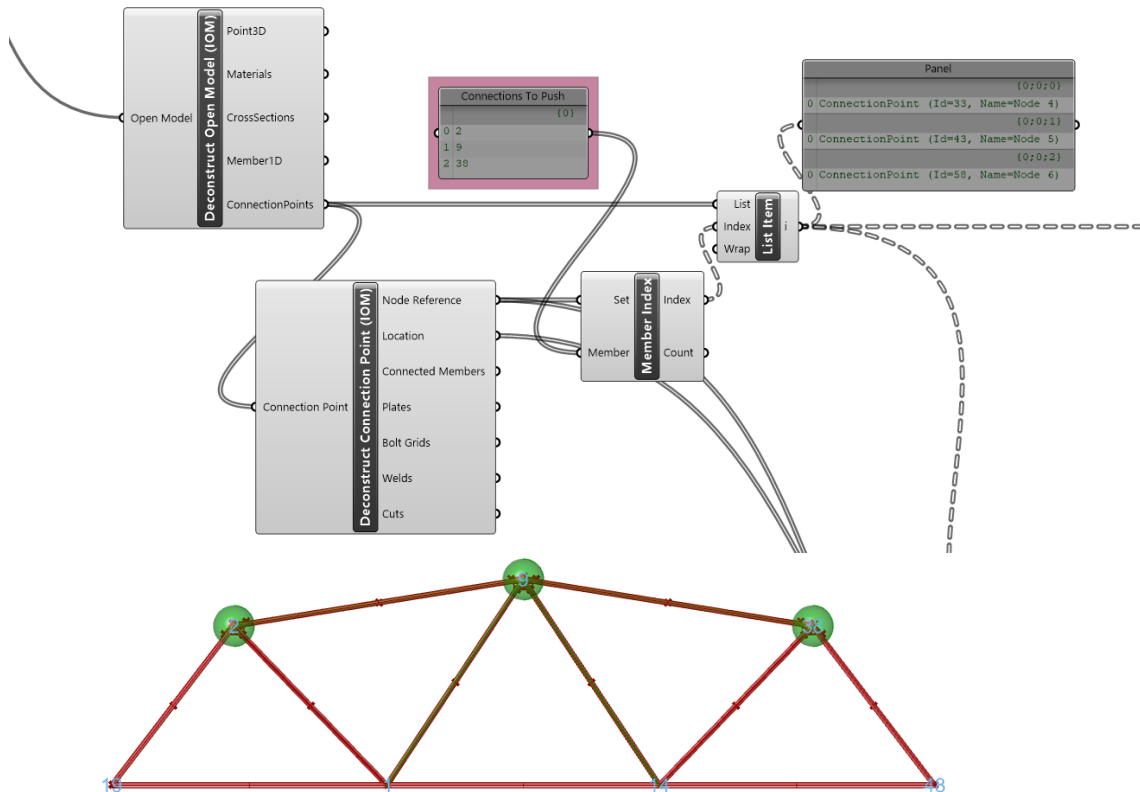
- Converts the SAF to IOM
- Automatically generates connection points.



# Explicit Component Geometry

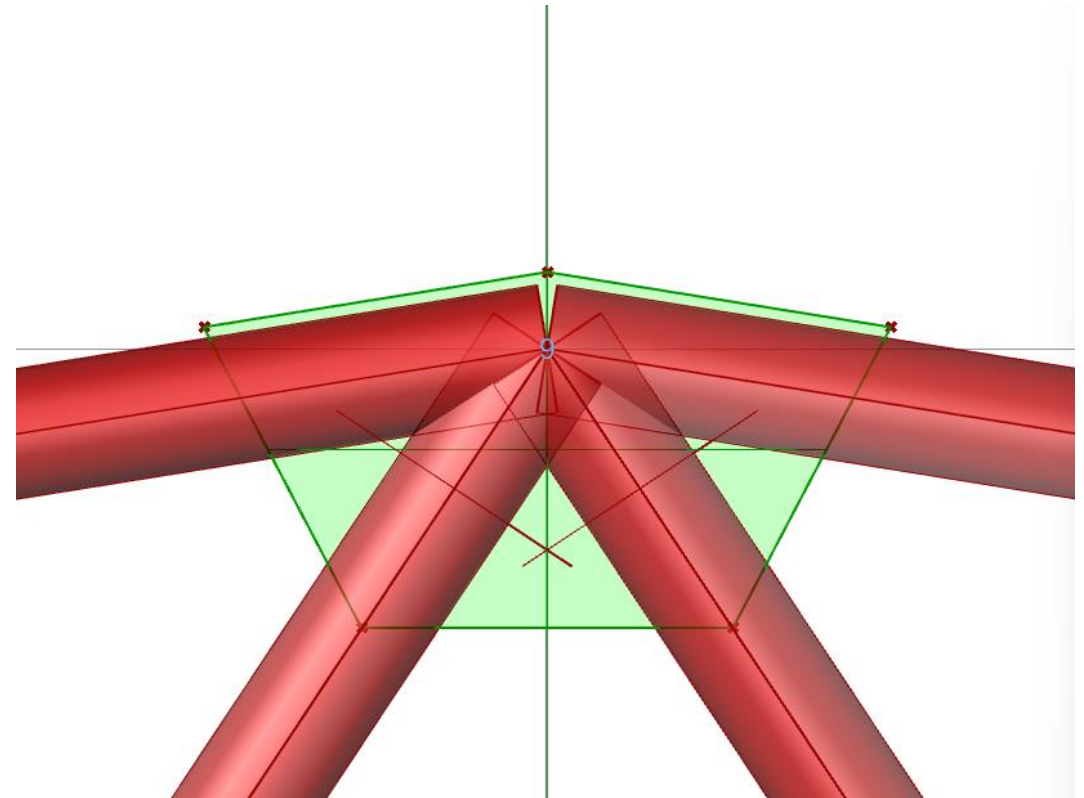
## Select Connections

1. Select/dispatch similar connection points



## Create Geometry

1. Before creating geometry, you will likely need to sort connected members to enable your
2. Create Rhino geometry using grasshopper.

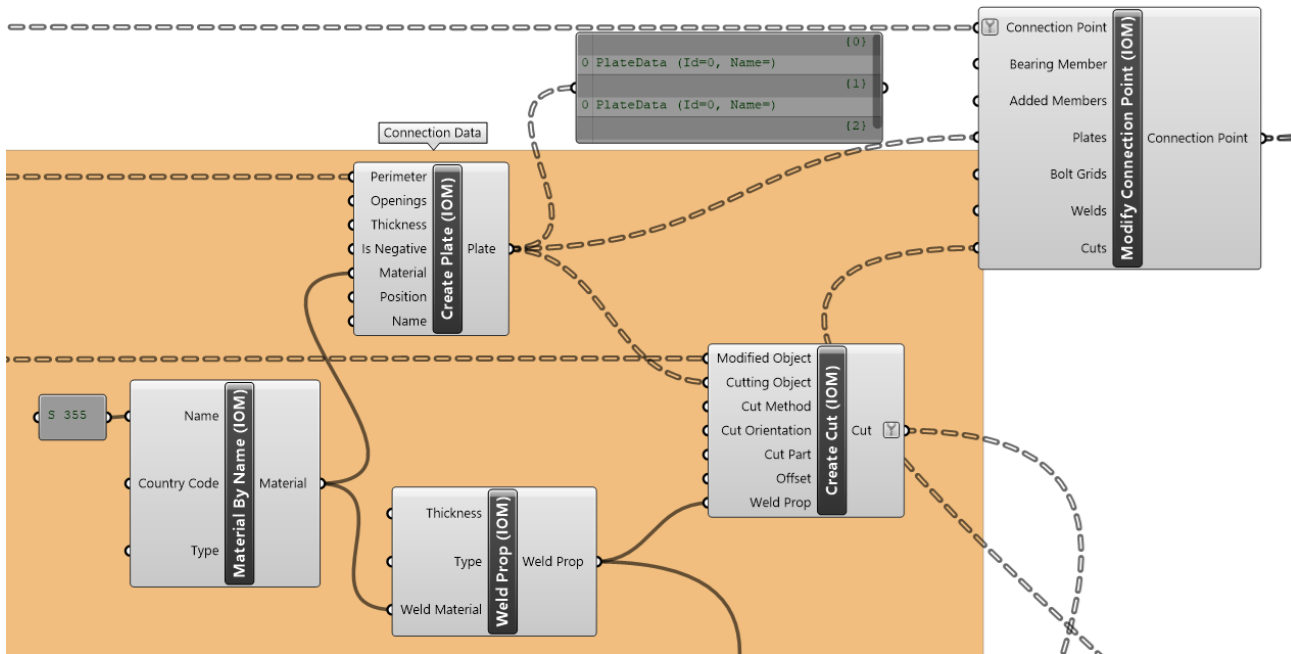


# Explicit Component Geometry

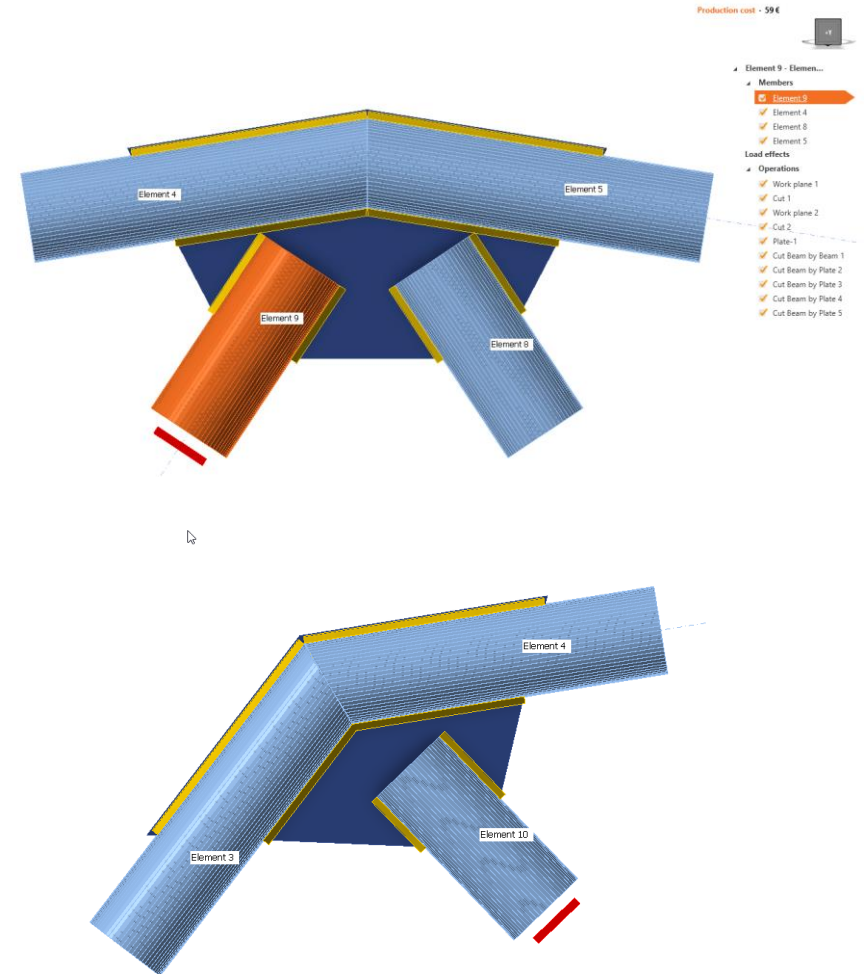
## Create IOM Objects and Add them to the Connection Point

### 1. Automate cuts:

- Cut of members,
- Member cuts between plates
- Plane cuts



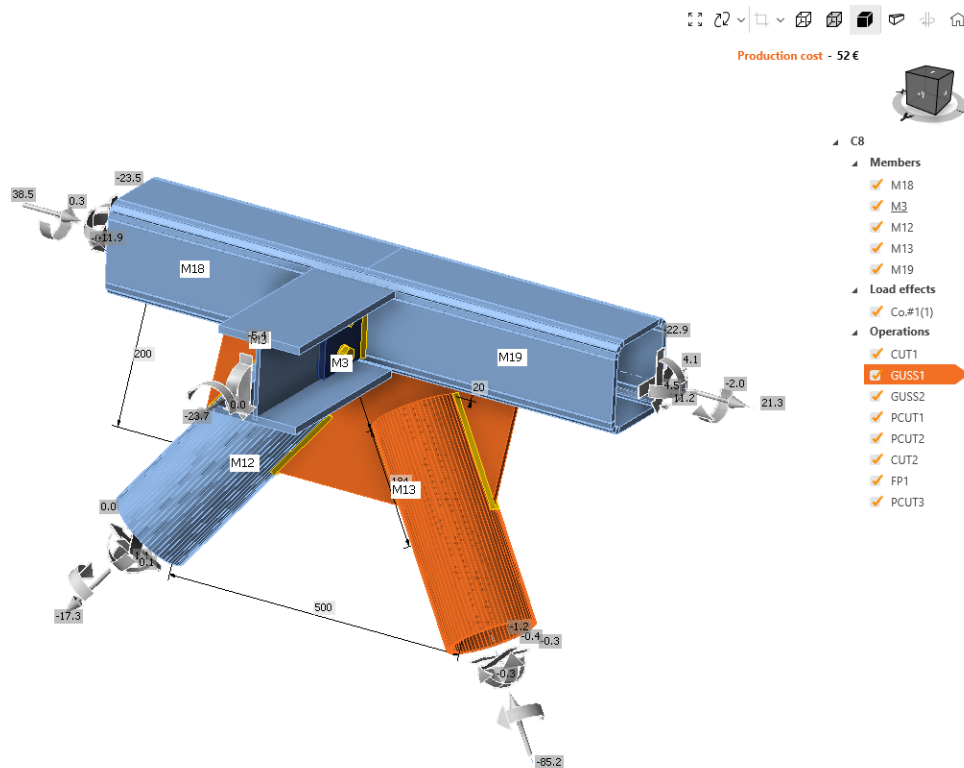
## Create Connections files



# Template Application

## Create Template

1. Create a template from a similar connection and save it.



## Set Parameters

1. We can set some parameters that we would like to change in grasshopper.

Parameters

Model properties

Set to model

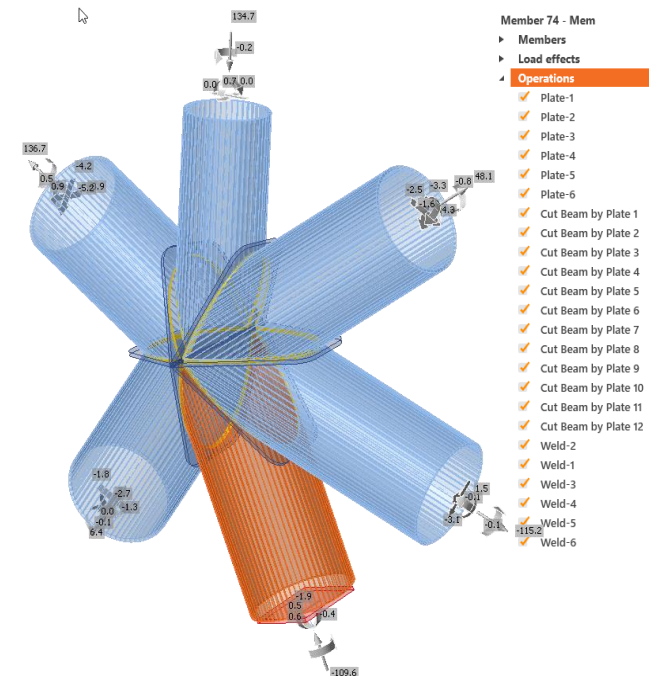
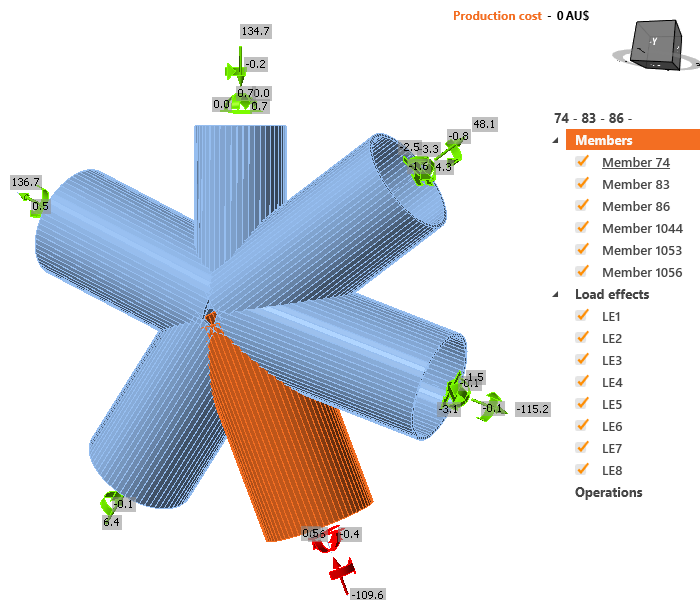
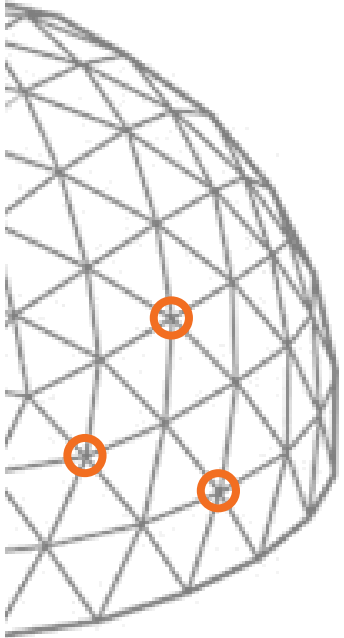
	Parameter Id	Description	Expression	Value	Unit	Visible	Valid	
	plate_width		0.5	0.5	None	<input type="checkbox"/>		...
>	plate_depth		0.2	0.2	None	<input type="checkbox"/>		...
	plate_thk		0.01	0.01	None	<input type="checkbox"/>		...

[Reference Guide](#)

# Spatial Connection

*"I have basic member geometry and loading and need to automate the adding of connection components."*

150 connections all model automatically by one script = HUGE TIME REDUCTION



StatiCa

CONNECTION

Calculate yesterday's estimates

Node 41

Project

Design

Check

Report

Materials

Developer

A - B - C - D - E - F

New Copy

Undo Redo Save

Members Plates LCS

New Gallery

Propose Publish Manage

Code Calculate Overall setup check

Settings

Loads in equilibrium

Loads - percentage

XLS Import

Connection Import

XLS Export

Model Load Operation entity

Project items

Data

Labels

Pictures

Connection Library

CBFEM

Options

Import/Export loads

New

Production cost - 0 AUS

A - B - C - D - E - F

Members

- Member A
- Member B
- Member C
- Member D
- Member E
- Member F

Load effects

- LE1

Operations

111.1

-0.2

0.6

0.0

0.0

0.6

Member B

Member E

Member F

Member C

Member B

Member D

Member A

Member F

113.1

0.4

39.6

-0.6

-2.7

-2.1

3.5

1.3

1.3

0.1

0.1

-0.1

-2.6

5.4

-0.1

0.5

-0.3

-90.5

-95.4

A - B - C - D -

Project item

Name

A - B - C - D - E - F

Description

Analysis type

Stress, strain

Report

You can add text and pictures

Design code: AS

Analysis: Stress, strain

Load effects: In equilibrium

Units: mm

29°C

High winds soon

Search

ENG US

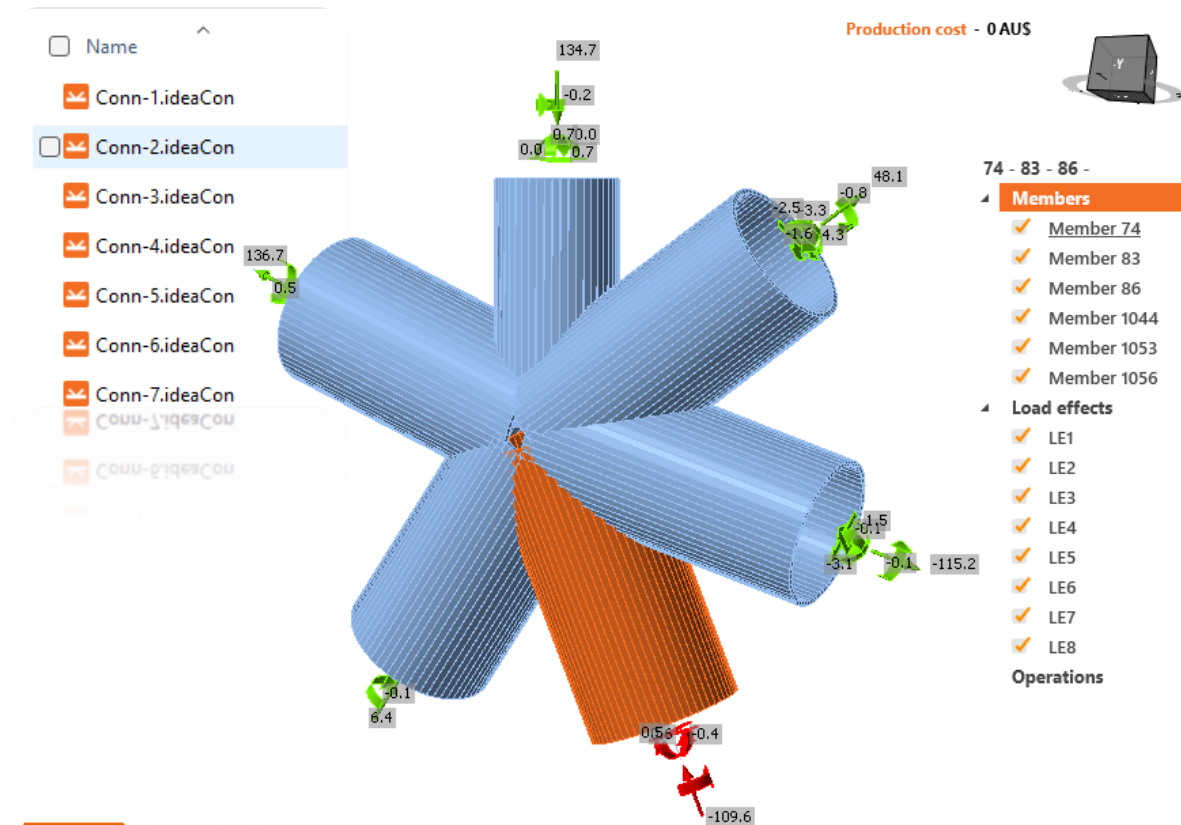
11:14 AM

13/12/2023

# Spatial connection (1)

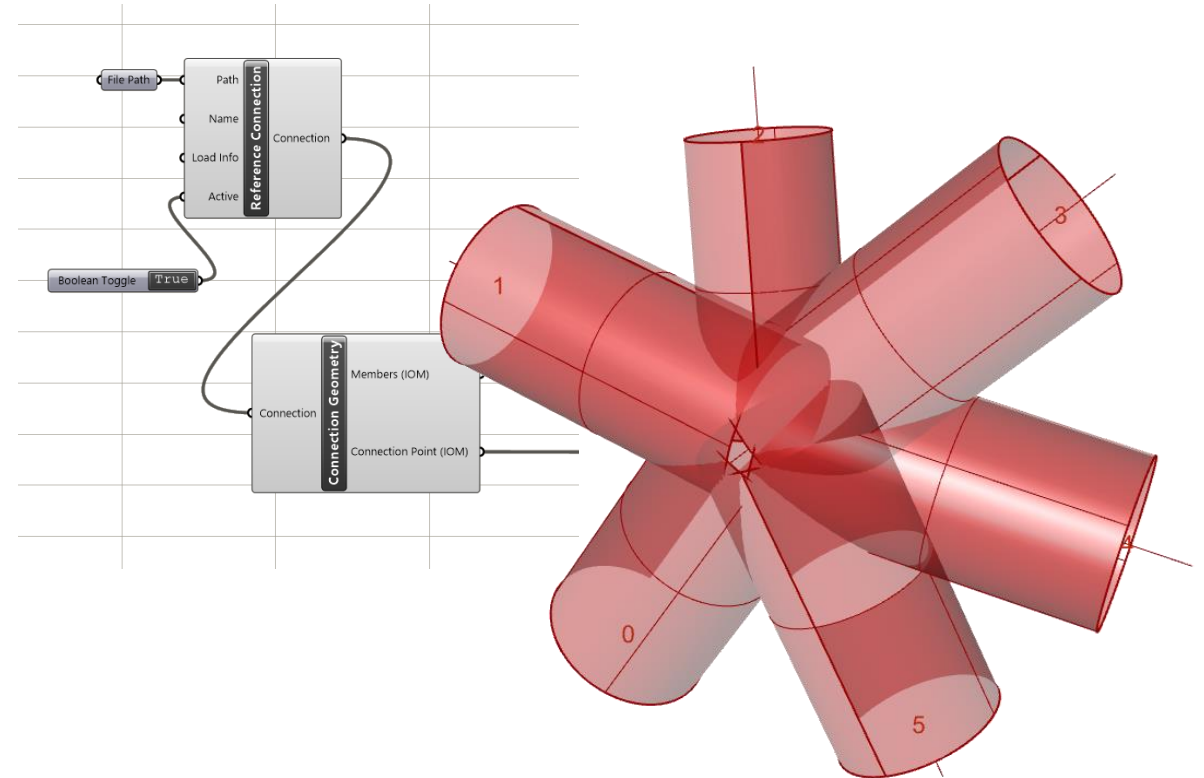
## 1. Conversion

- FEA conversion to IDEA Connection files (~150)



## 2. Geometry in Rhino

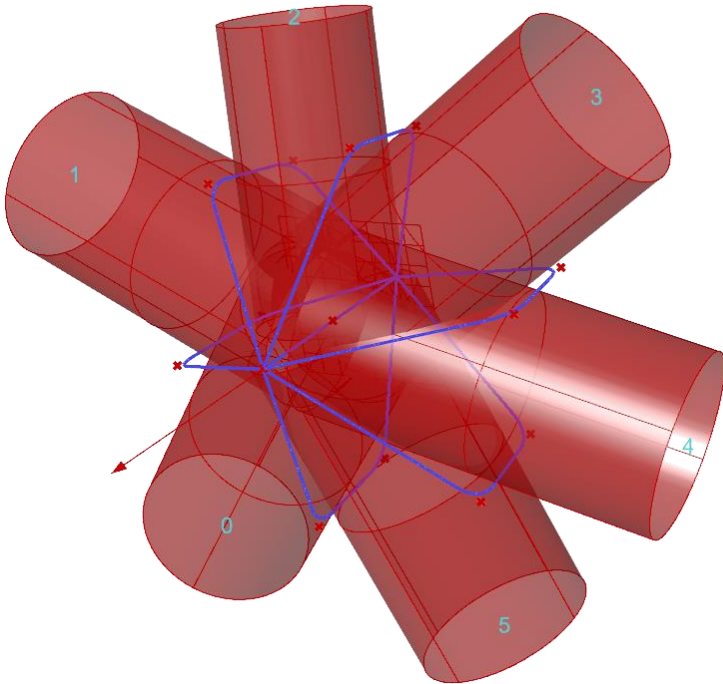
- Import the existing connection
- Extract member geometry



# Spatial connection (2)

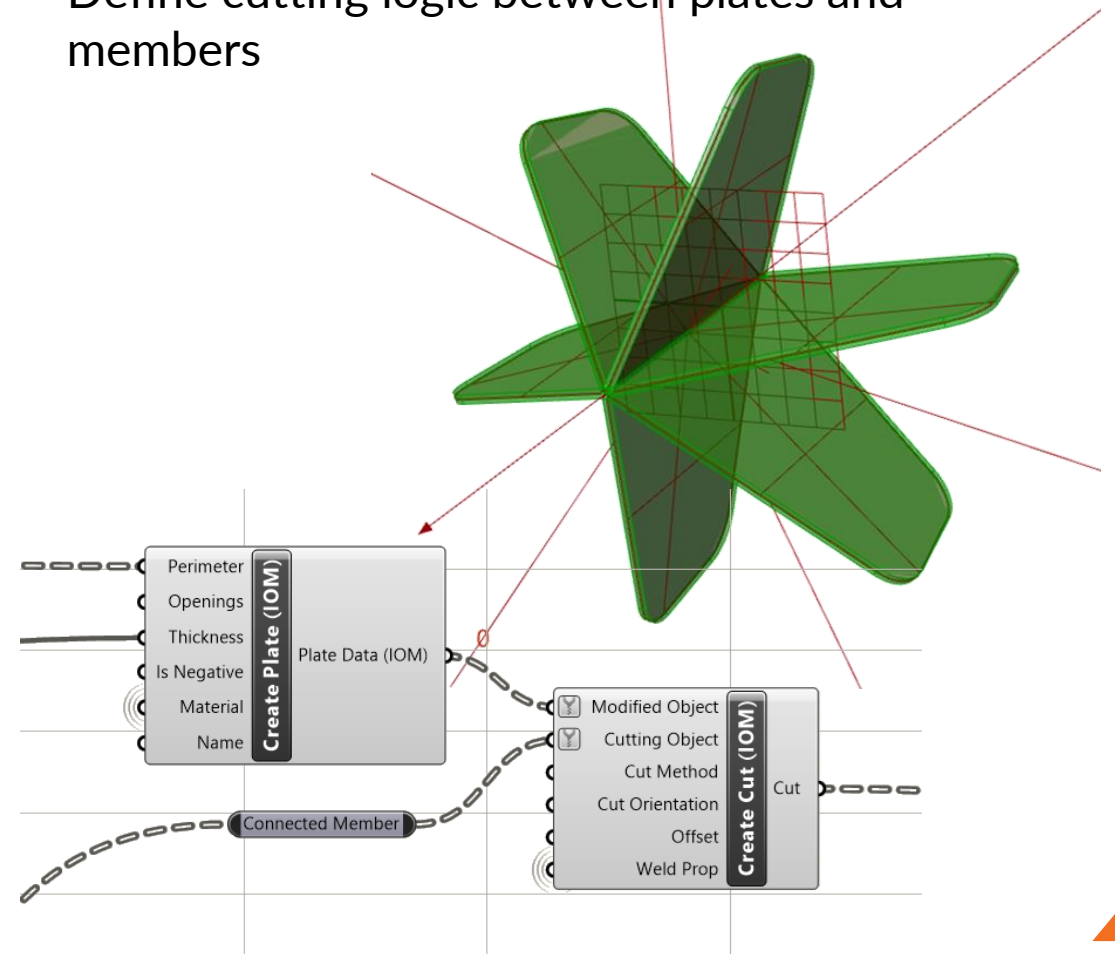
## 3. Geometric calculations with Grasshopper

- Calculate average plane
- Perform BREP Intersections
- Create parametric outline geometry



## 4. Create IOM Operations

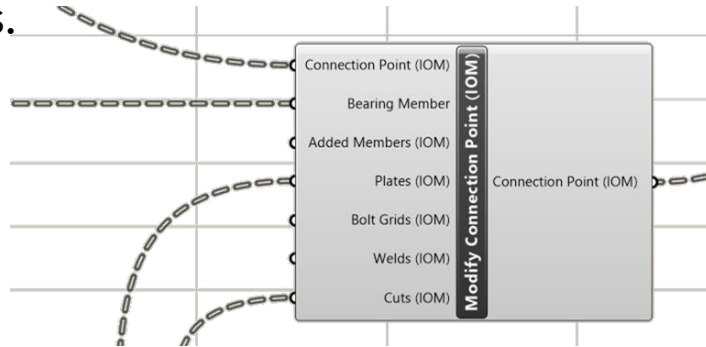
- Create IOM plates from Rhino geometry
- Define cutting logic between plates and members



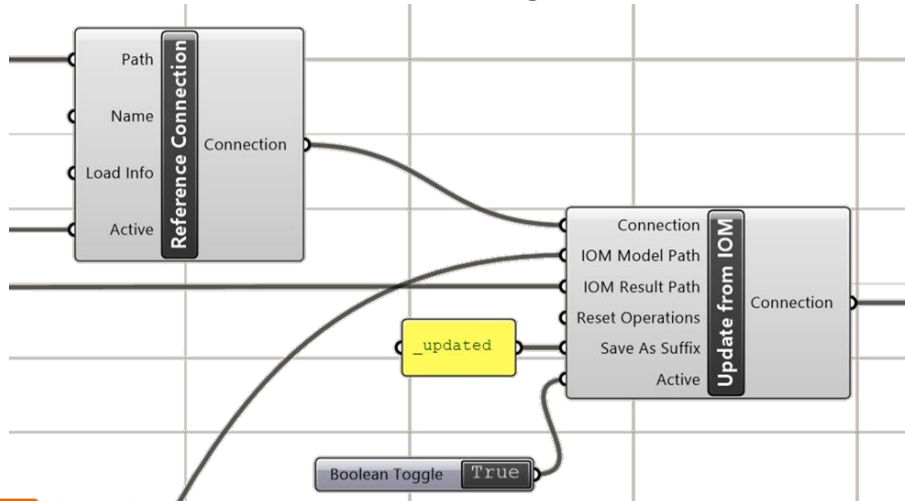
# Spatial connection (3)

## 5. Assign to Connection

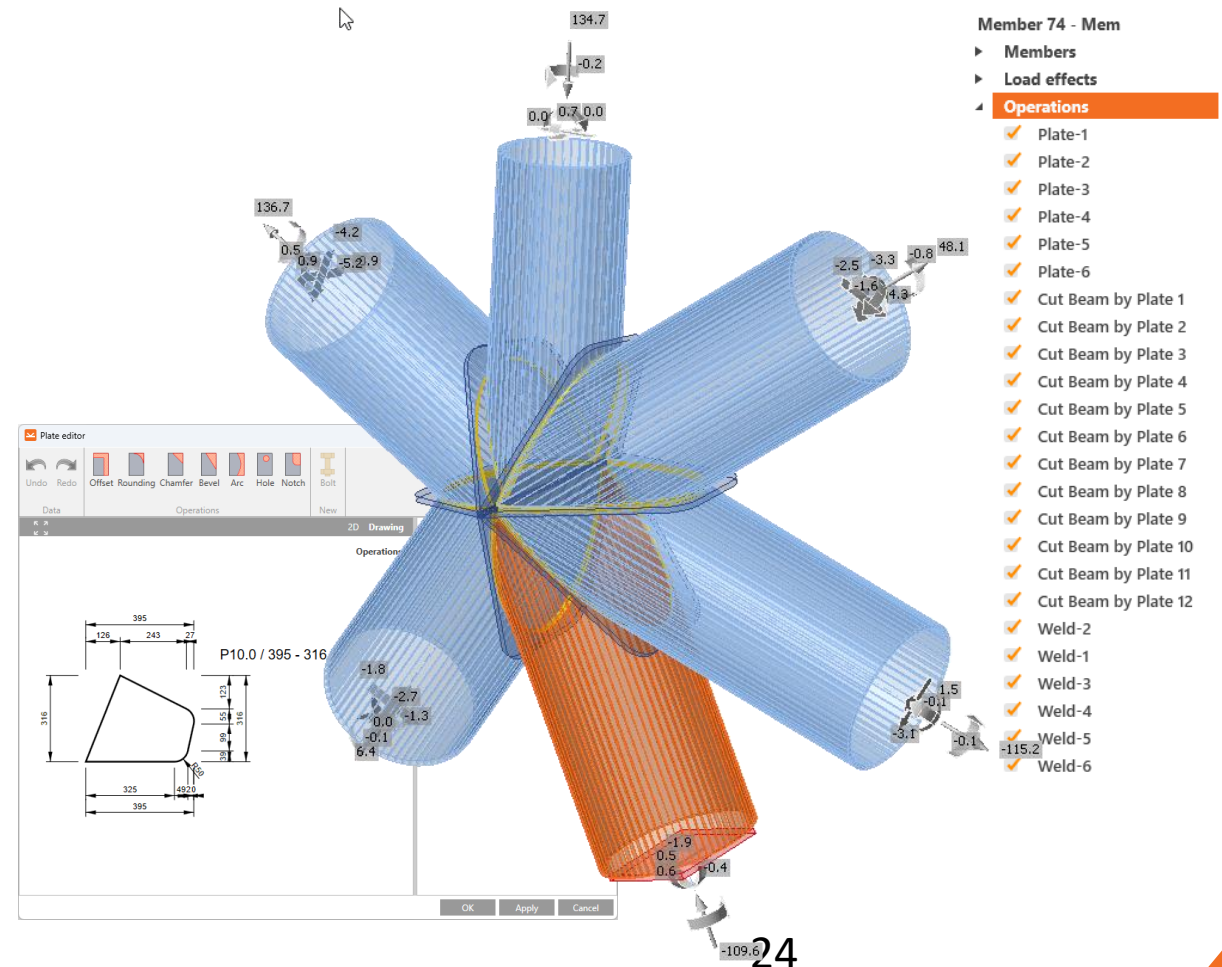
- Update the connection point with GH defined operations.



- Push back into existing connection.



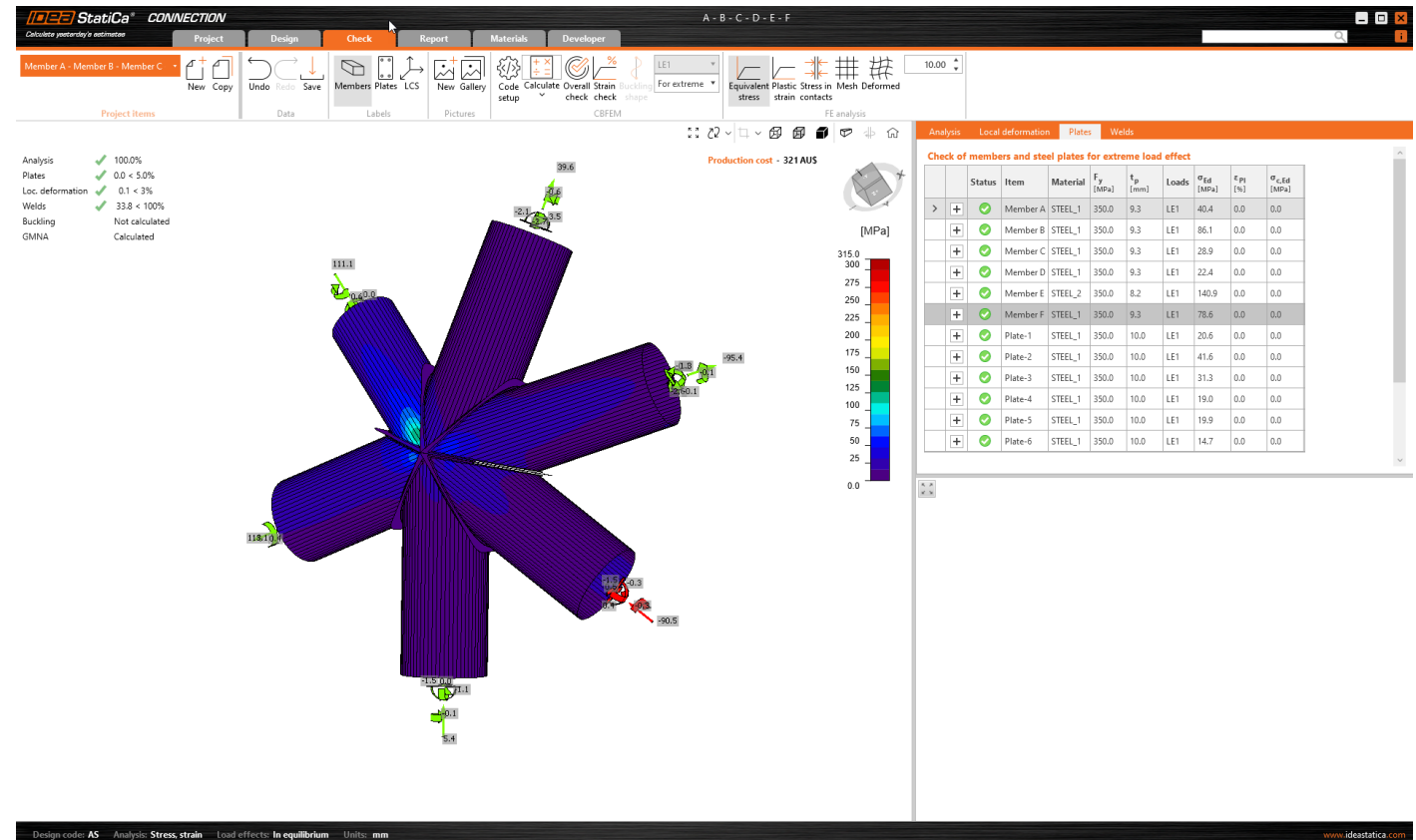
## 6. Updated Connection



# Spatial connection (3)

## 5. Calculate

- Calculate the connection in Grasshopper or open in the Connection App.



# Further Resources

## Developer Website

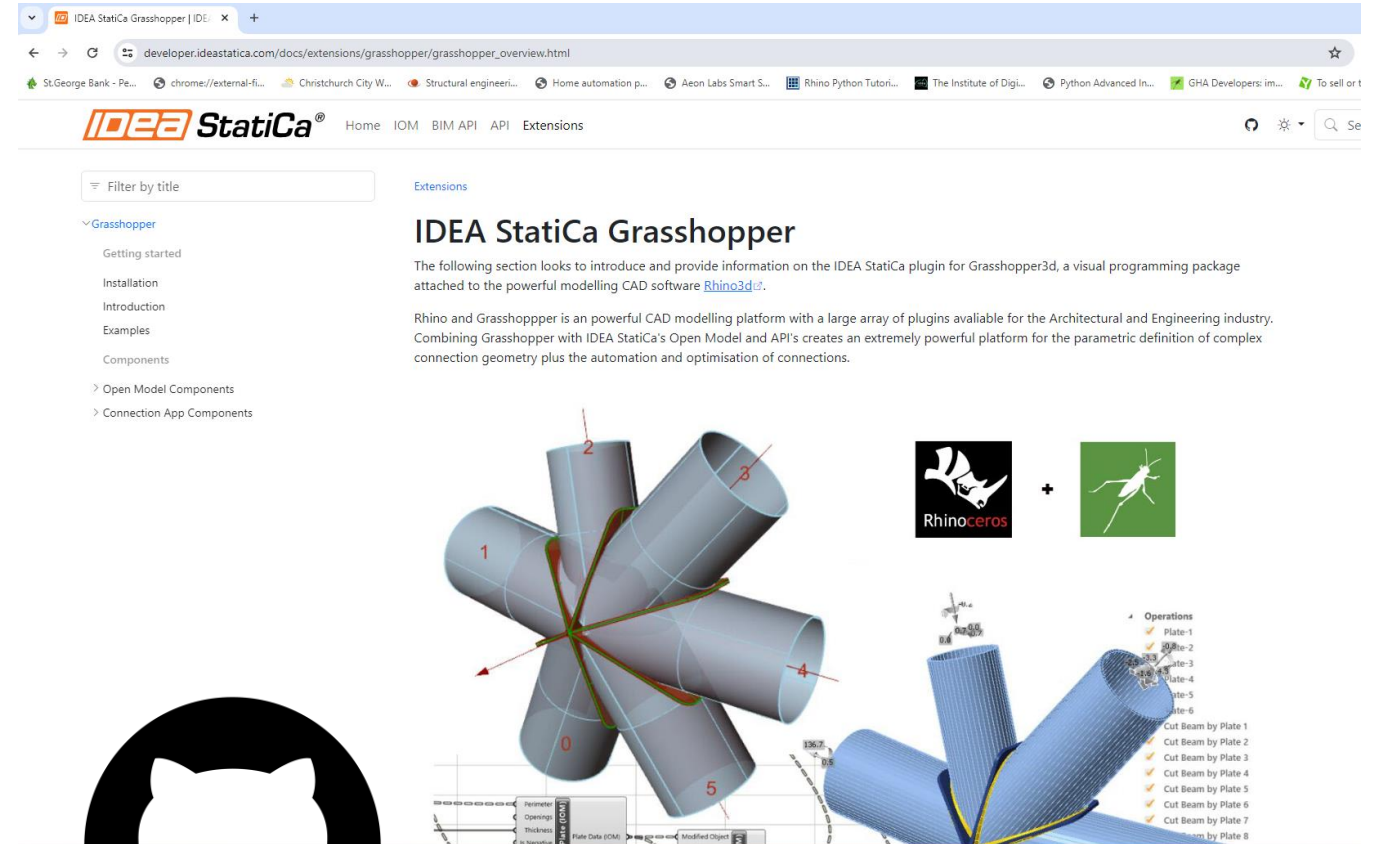
- Documentation on Grasshopper and API
- [developer.ideastatica.com](https://developer.ideastatica.com)

## Public GitHub

- Discussions / Issues
- [github.com/idea-statica/ideastatica-public](https://github.com/idea-statica/ideastatica-public)

## Everything else

- [www.ideastatica.com](https://www.ideastatica.com)

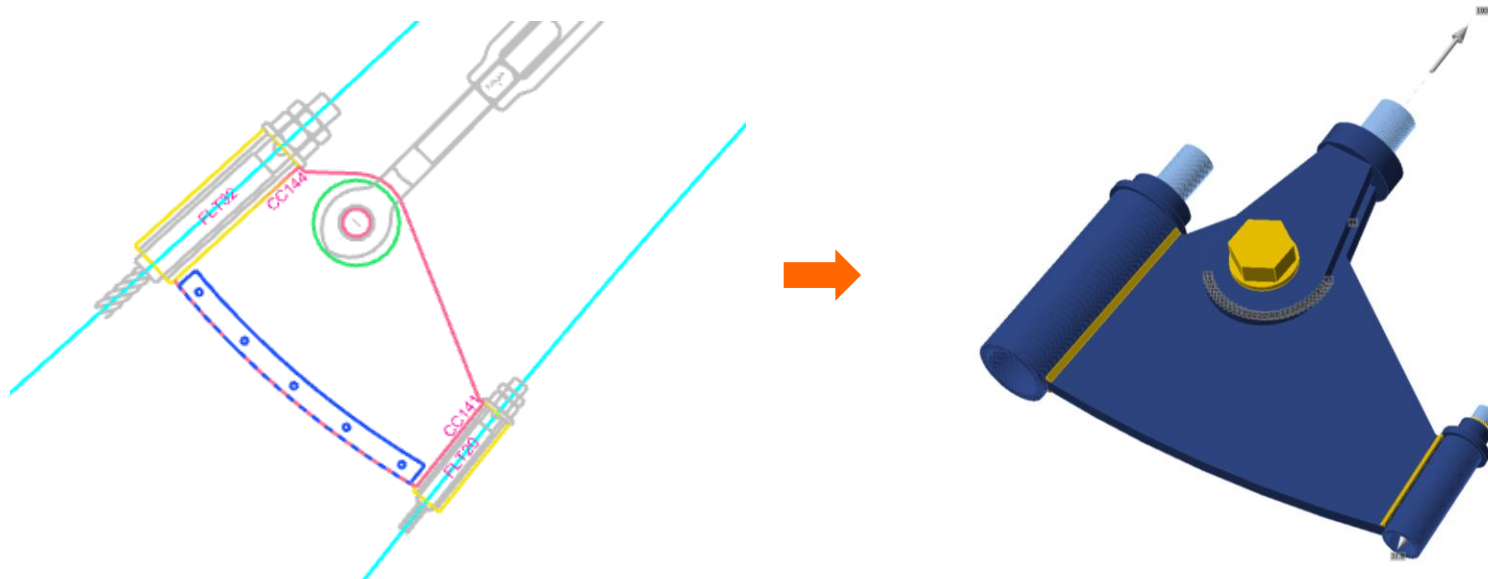


# *Thank You*

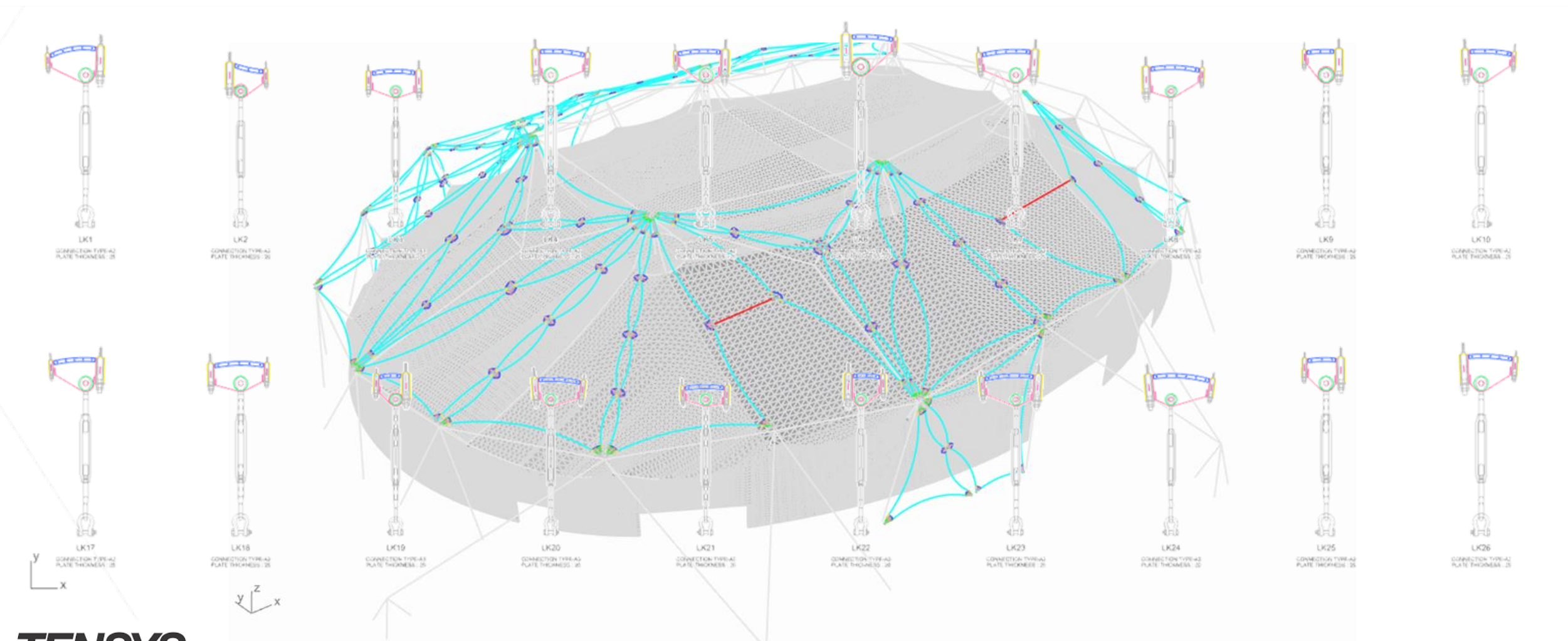
**Nathan Luke**  
BIM & API Specialist  
IDEA StatiCa HQ  
[linkedin.com/in/nathan-luke](https://www.linkedin.com/in/nathan-luke)

# User workflows

*“I have CAD geometry in AutoCAD or Rhino3D and need to  
generate complete connection files from scratch.”*



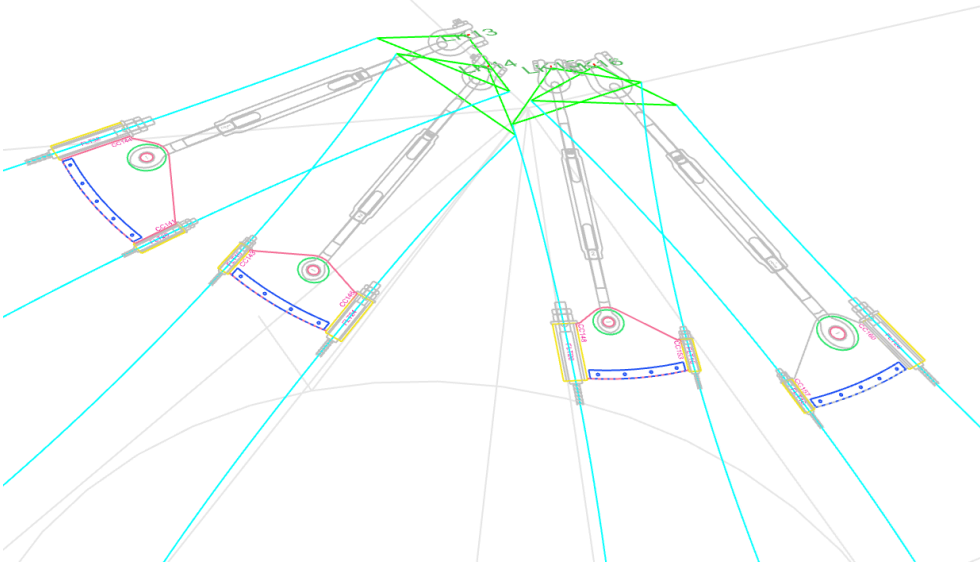
# Tensile connection (POC)



# Tensile connection (1)

## 1. Reference CAD (Rhino3D)

- Reference geometry into Grasshopper



- Extract data attributes

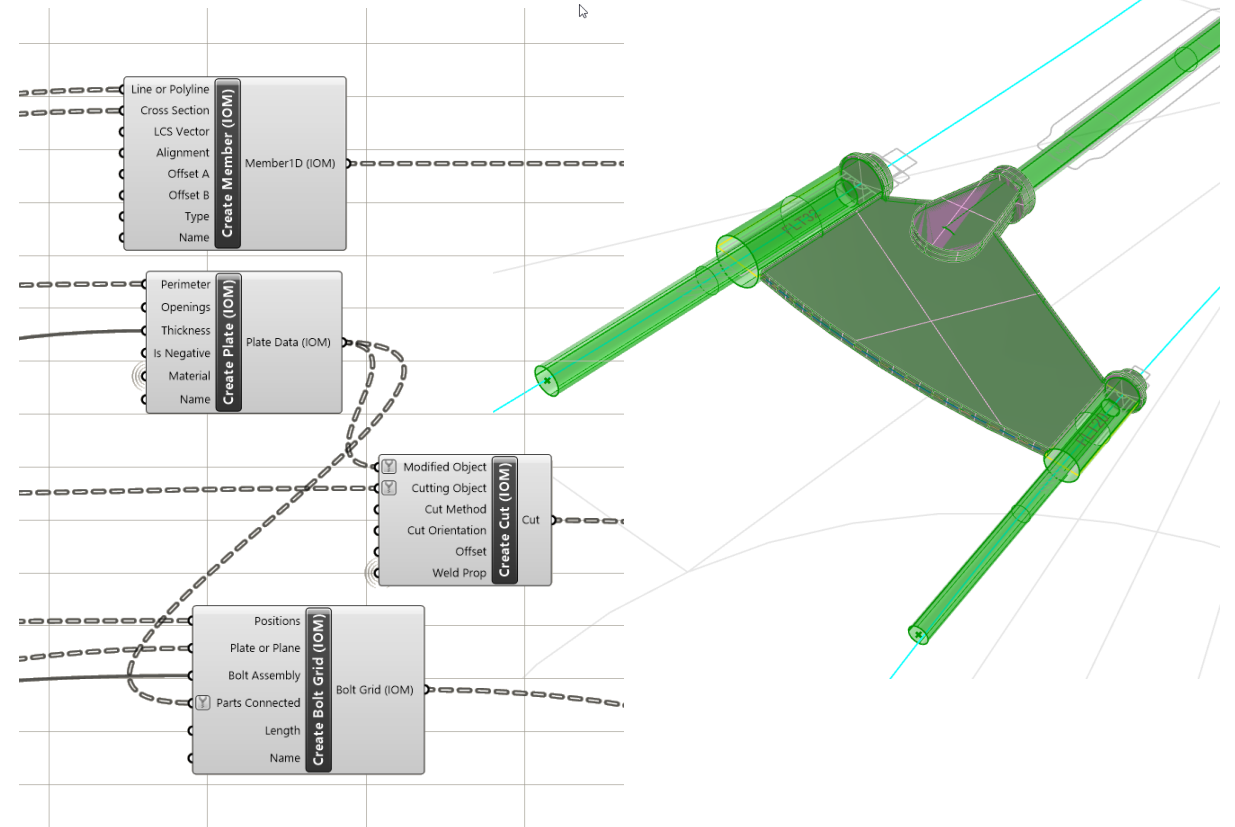


EleFront

```
5 attributes user strings.  
<Link Label> LK13  
<Link Type> TYPE-A2  
<Ref Plane> {-366.3, -17683, 24222.8};{-0.968634,-0.210726,-0.131694};{0.241688,-0.922094,-0.302207}  
<Plate Thk> 25  
<BakeName(Connections)> {0;127}(6)  
Command:
```

## 2. Create IOM Model Objects

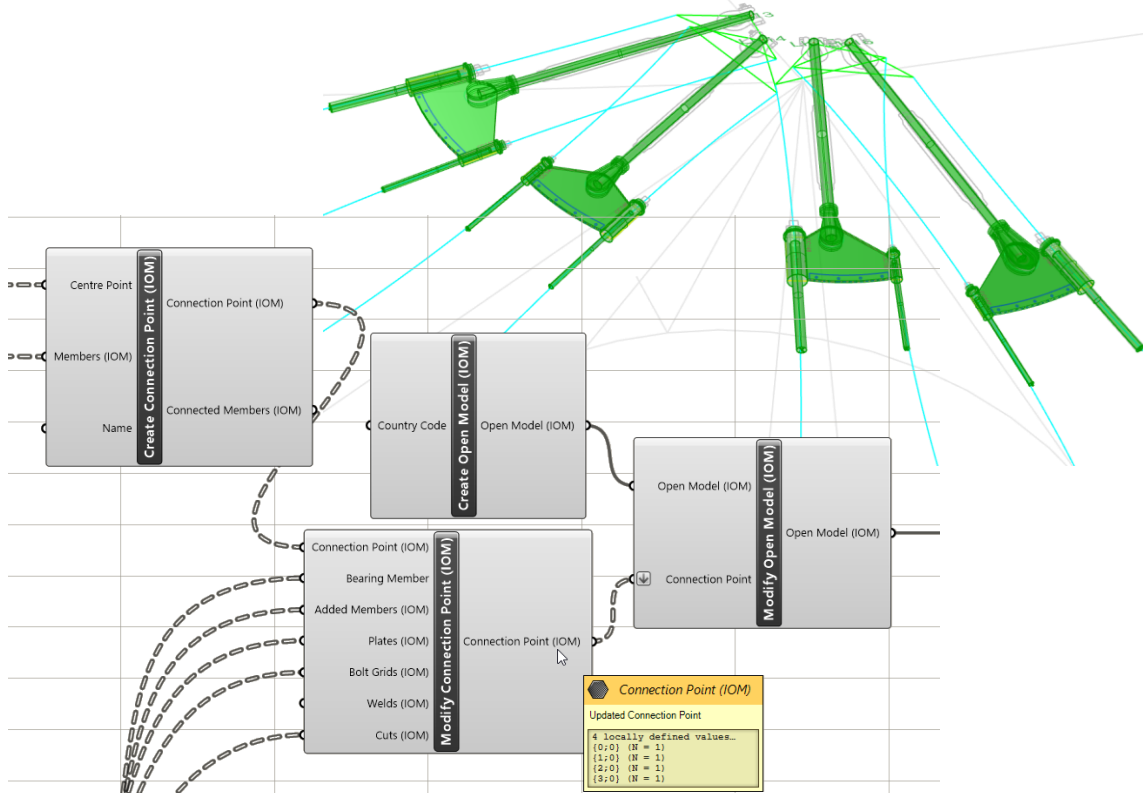
- Create members and 'added' members
- Create plates, cuts, bolt grids, contacts and welds



# Tensile connection (2)

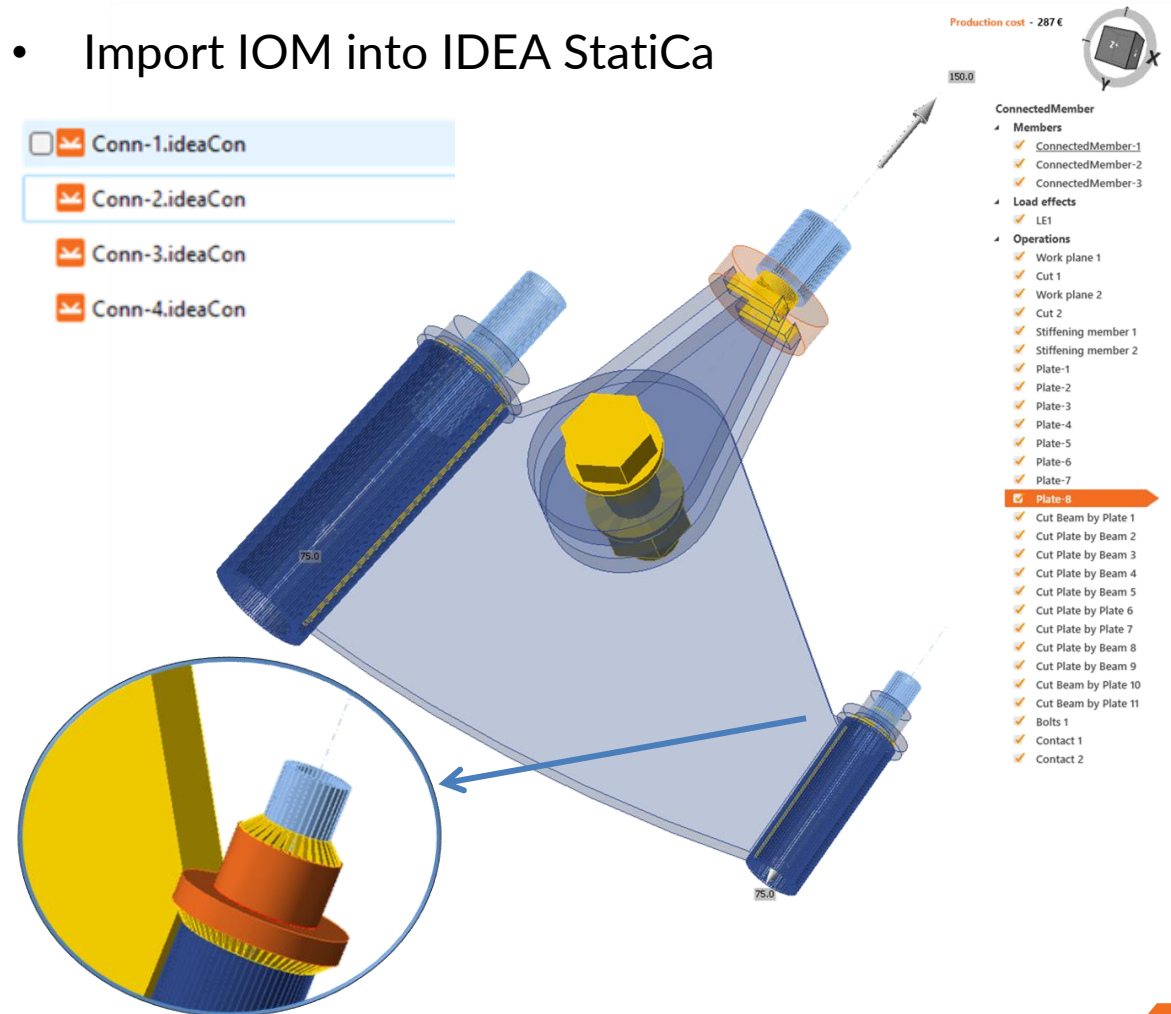
## 3. Create IOM Model

- Define connection points
- Assign connections to new Open Model



## 4. Save IOM and Open

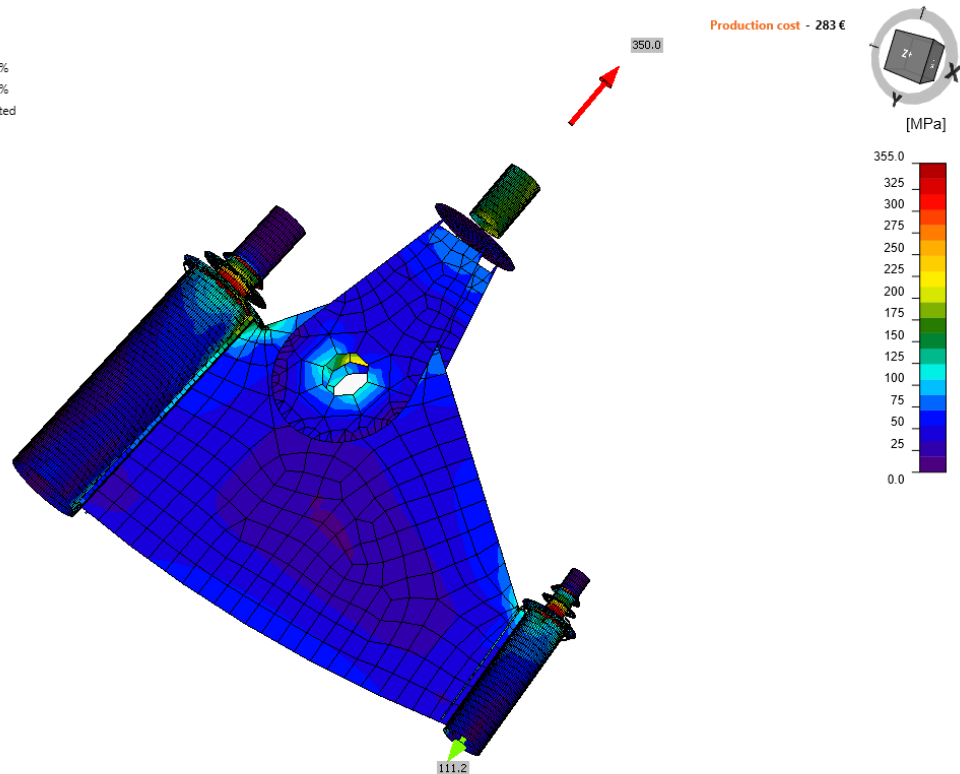
- Import IOM into IDEA StatiCa



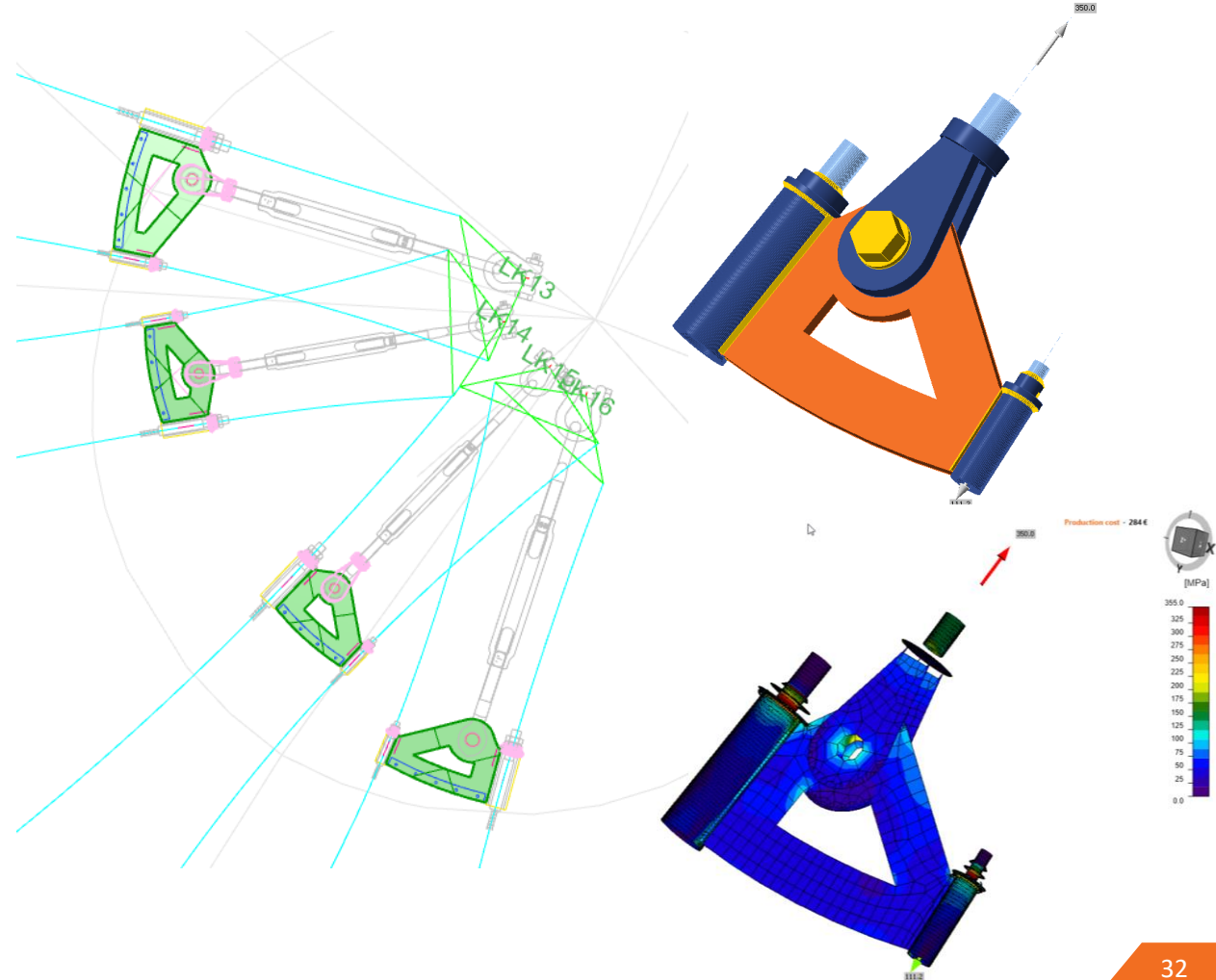
# Tensile connection (3)

## 5. Perform connection analysis

Analysis	✓	100.0%
Plates	✓	2.6 < 5.0%
Bolts	✓	49.0 < 100%
Welds	✓	98.2 < 100%
Buckling	✓	Not calculated
GMNA		Calculated



## 6. Optimise connection weight



*Calculate yesterday's estimates*